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(54) Abstract Title
A suction cleaning device having a fluid stream for dislodging material from a surface

(57) A cleaning device has means (52) for directing a stream of fluid at or over a surface (53) of an item to be cleaned whereby to dislodge material therefrom as a result of the kinetic energy of the fluid stream, means (55) for collecting substantially the entirety of the fluid stream after impact at the surface, together with any entrained particles dislodged at the surface thereby, and means (65) for introducing into the said fluid stream a treatment agent to be brought into contact with the surface (53) by the said fluid stream.

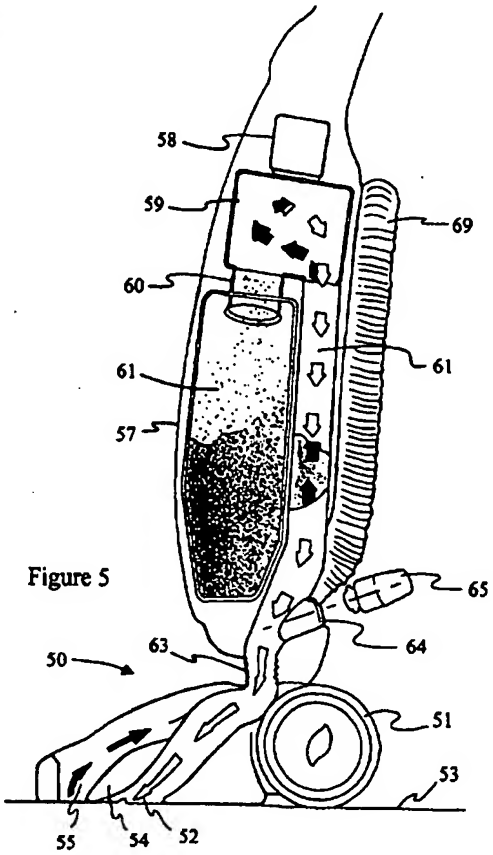


Figure 5

GB 2 338 404 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

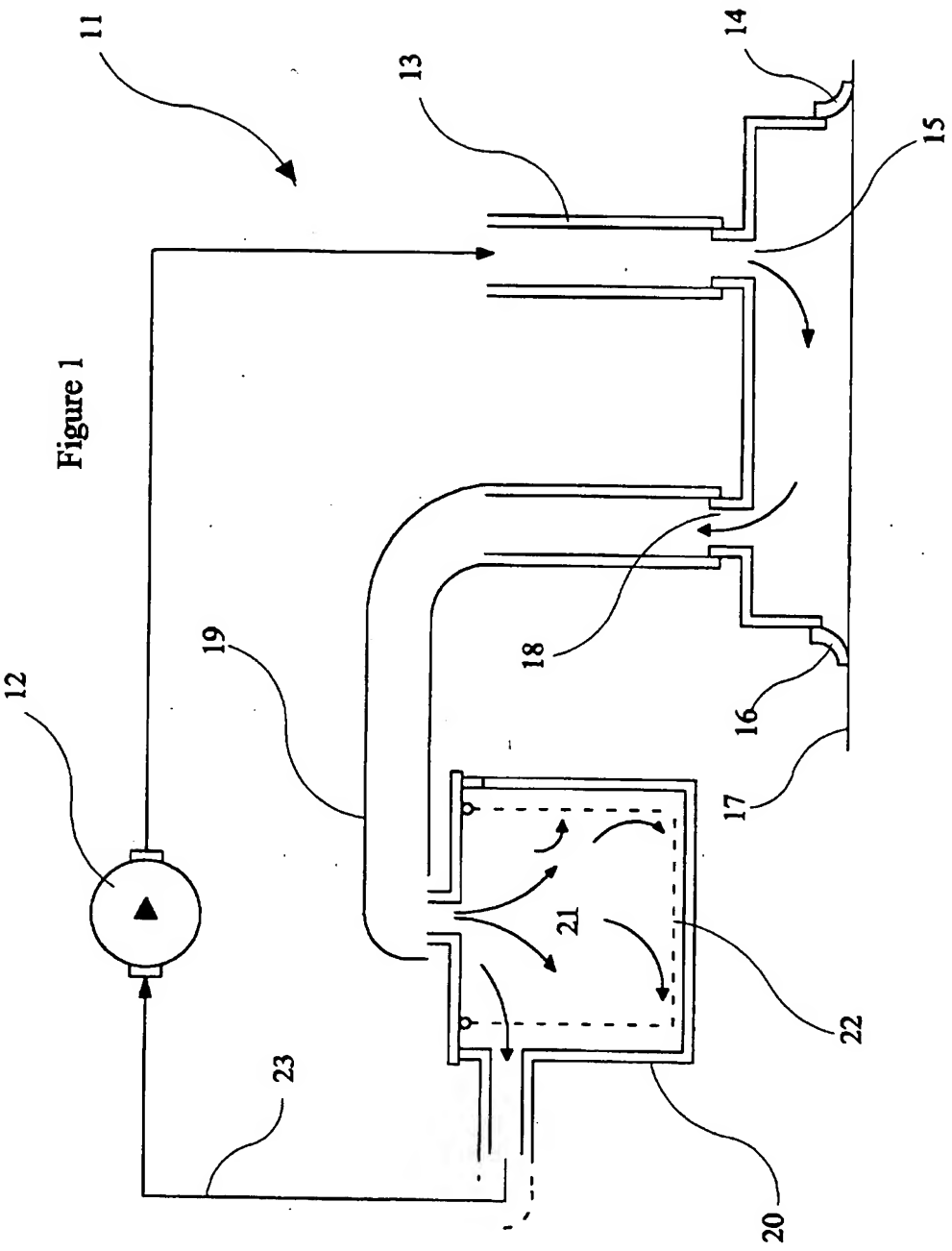


Figure 1

Figure 2

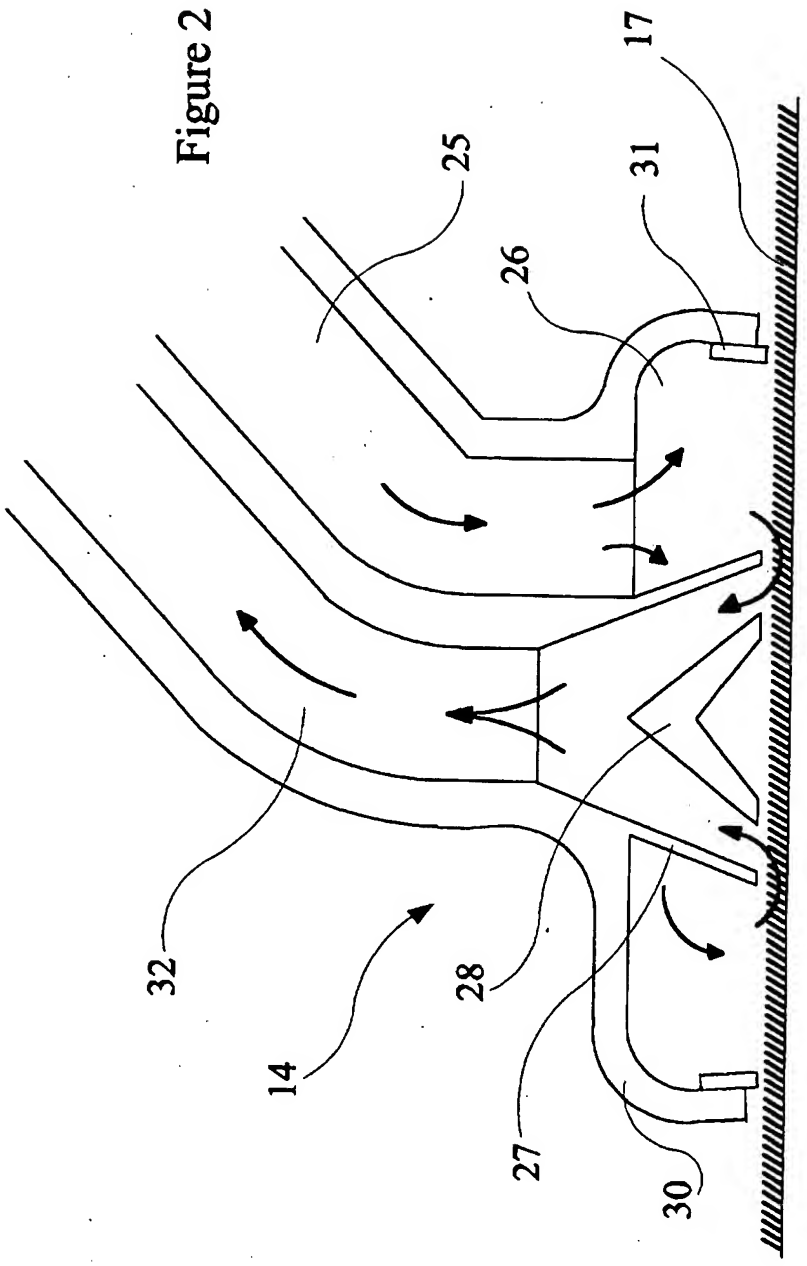
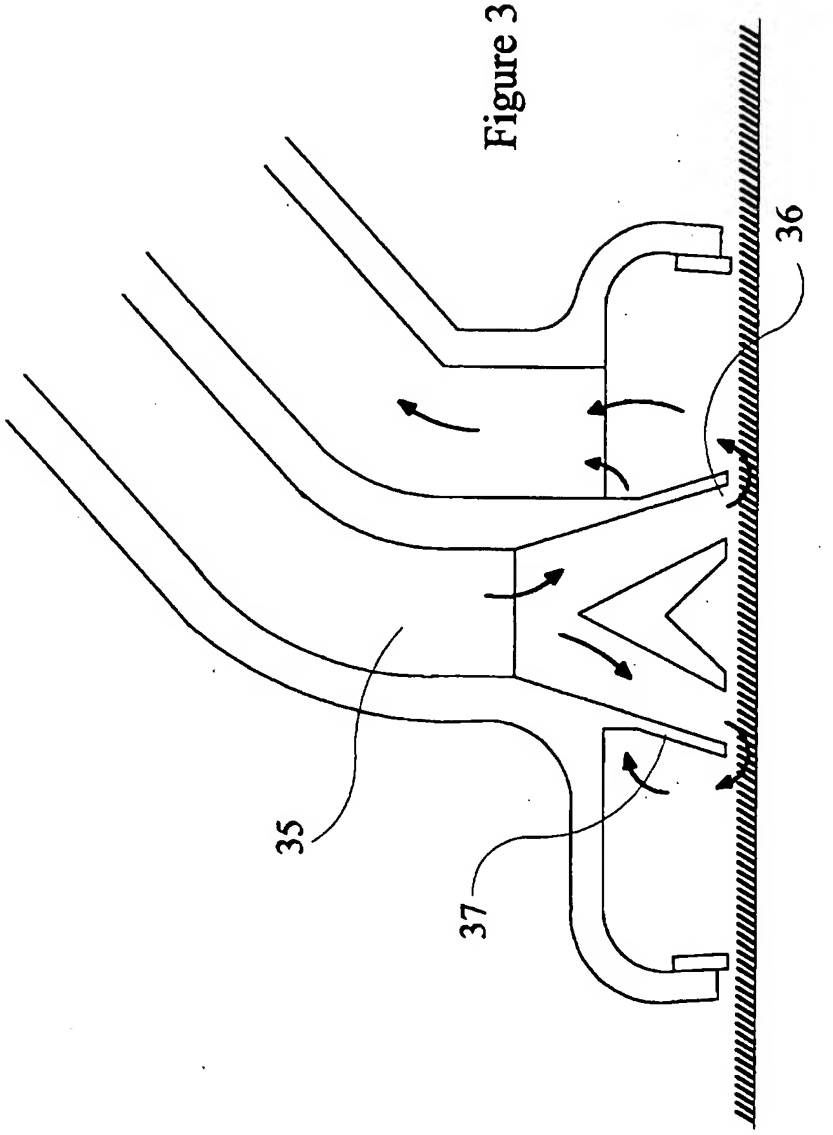


Figure 3



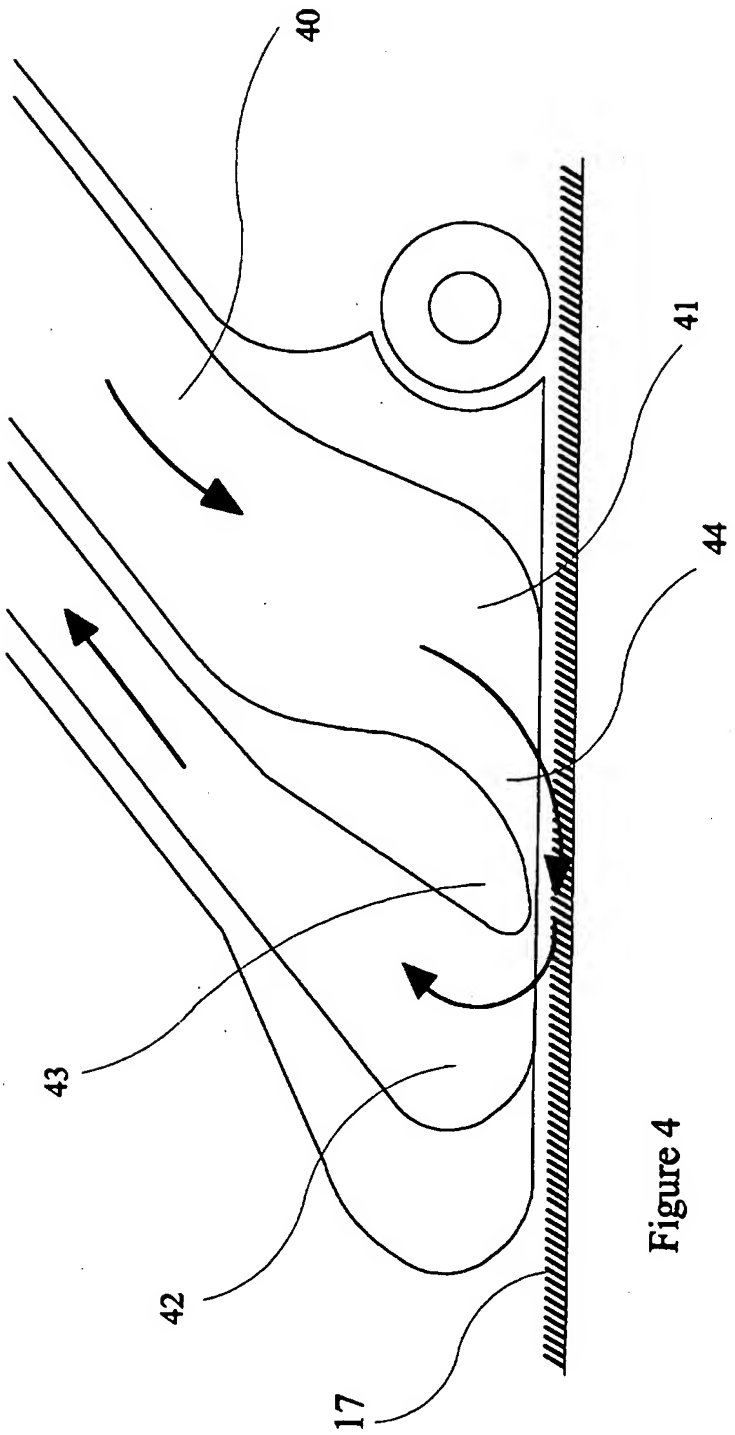


Figure 4

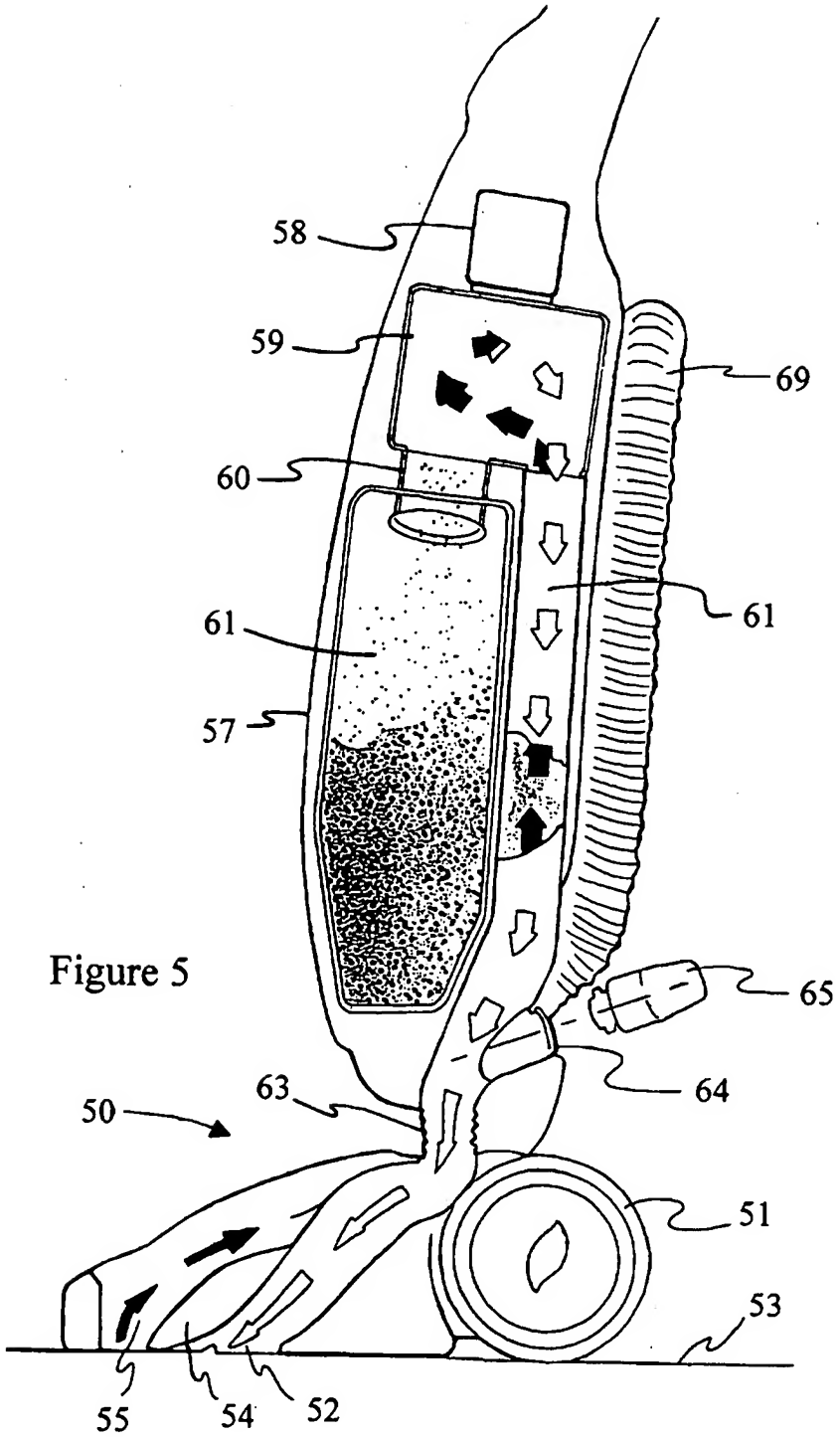


Figure 5

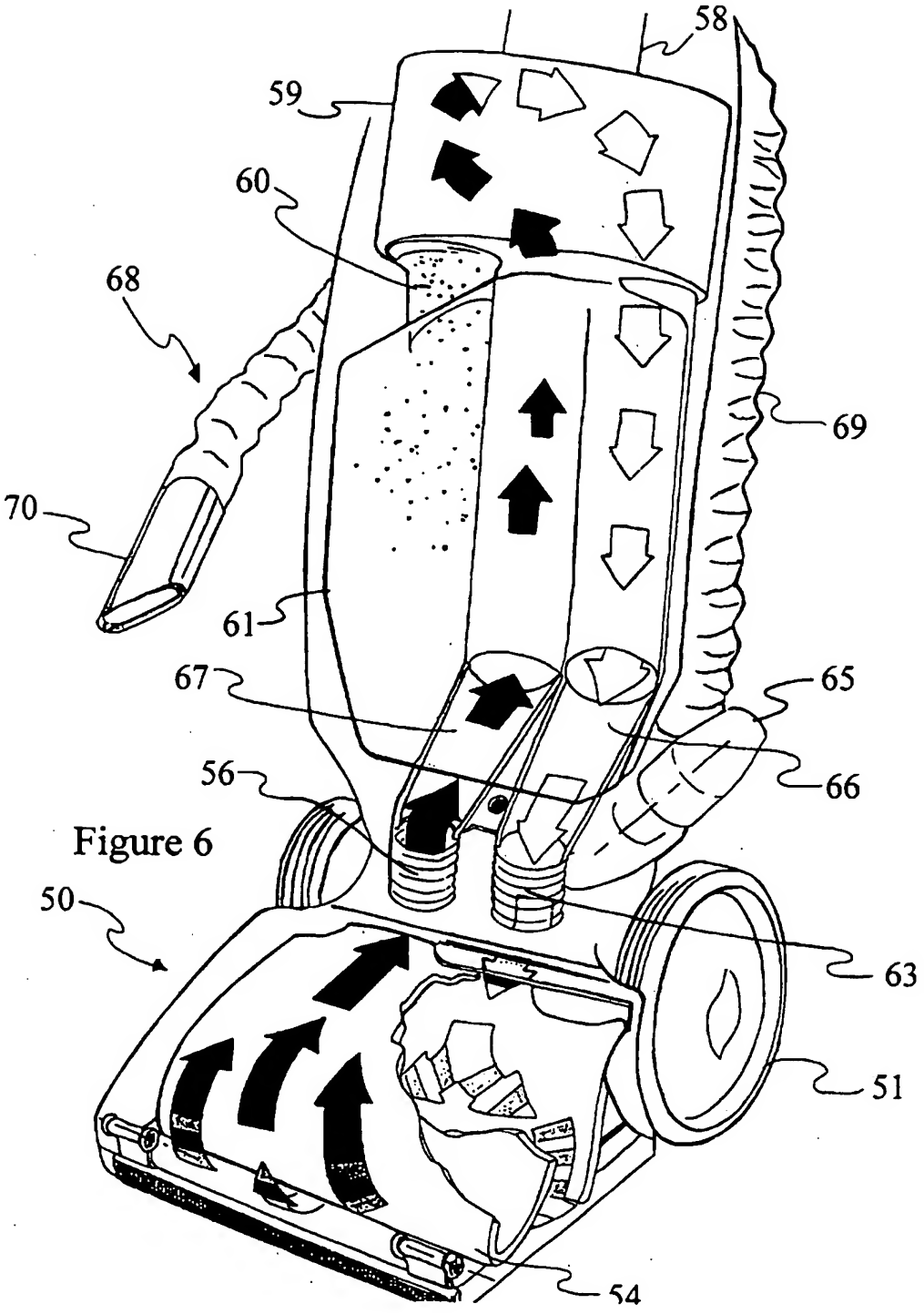


Figure 6

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A CLEANING DEVICE

The present invention relates generally to a cleaning device, and particularly to an improved cleaning device acting to remove unwanted material from a surface by purely physical means.

Various devices for cleaning surfaces such as floor surfaces are known, of which perhaps the most widely used is the so-called vacuum cleaner which acts to remove material from a surface by suction.

In known vacuum cleaners the air drawn from the region of the surface being cleaned, carrying entrained particles, is passed through a filter before being emitted to the atmosphere. Such filters are only able to remove particles greater than a certain minimum size and particles below that size are returned to the atmosphere with the air stream. Recently attempts have been made to minimise the amount of dust returned to the atmosphere from a vacuum cleaner by introducing additional filters having various different effects but such filters are of limited use in that they rapidly become clogged and impede the flow of air or become ineffective and allow particulate material to pass through back to the atmosphere.

More recently attempts have been made to separate the

dust entrained with the suction air by utilising a cyclone, but cyclones also have a limit on the particle size which can be separated from the air, resulting from their design constraints such as the coneangle and the depth of vortex finder.

This problem can be mitigated by utilising a closed circuit for an active fluid, for example by recirculating an active fluid rather than simply drawing air from the atmosphere and returning it thereto. By using a re-circulation system there is, then, no problem of particulate material being returned to the air and the efficiency of any filters or other means for separating particulate material from the fluid stream becomes less critical. This, however, introduces other problems, one of which is overheating of the motor. Such a system is described in US 5 457 848, in which the problem of motor overheating is addressed by allowing a proportion of the hot recirculating air to escape and be replaced by cool air from outside. This arrangement then loses much of the benefit of recirculation and allows particulate material to re-enter the atmosphere. Other prior art documents include US 5647092, which describes a system in which pile fabrics can be impinged by air recirculated from a suction fan, and US 5613269, which describes a system in which the recirculated air is directed in a jet at the surface to be cleaned in order more positively to dislodge particles therefrom.

None of these prior art systems envisage the use of anything other than the mechanical action of the circulating fluid to dislodge the particles, and none offers any other form of cleaning action or treatment of the surface to be cleaned than the mechanical action of the circulating fluid.

Although the present invention will be described in relation to its application to a surface cleaning device in which air is the re-circulated fluid it is to be understood that other fluids, which may be liquid or gas, may be utilised as an alternative.

According to one aspect of the present invention, therefore there is provided a cleaning device having means for directing a stream of fluid at or over the surface of an item to be cleaned whereby to dislodge material therefrom as a result of the kinetic energy of the fluid stream, means for collecting substantially the entirety of the fluid stream after impact at the said surface, together with any entrained particles dislodged from the surface thereby, and means for introducing into the said fluid stream a treatment agent to be bought into contact with the surface by the said fluid stream.

The present invention thus opens up a range of possibilities for improving cleaning and widening the range of treatments which can be performed on a surface.

It is a particular feature of the present invention that the fluid may be directed at the surface to be cleaned in such a way that it impinges on the surface with high energy, for example being directed at the surface as a jet. The energy conveyed by the fluid acts mechanically to dislodge particles of material on the surface, which particles can then be entrained with the fluid and carried away from the surface. Such devices are of particular value in cleaning carpets and other fabric material, although the principle can be applied to hard surfaces as well. By introducing a treatment agent to the stream of fluid just before it is directed onto the surface to be treated it is possible, for example, to deliver an insecticide or a deodorant to the surface, or to deliver an ingredient which will assist cleaning, such as by reducing surface tension or by introducing magnetic particles the adhesion of the dust to the surface may be reduced. This may also be achieved by pulsing the delivered stream or by introducing ultrasonic vibrations as will be described in more detail below.

According to another aspect of the present invention there is provided a cleaning device having means for directing a stream of fluid at or over the surface of an item to be cleaned whereby to dislodge material therefrom as a result of the kinetic energy of the fluid stream, and means for collecting substantially the entirety of

the fluid stream after impact at the said surface, together with any entrained particles dislodged from the surface thereby, in which there are provided means for introducing pressure variations in the stream of fluid directed at the surface.

The means for directing a stream of fluid at or over the surface of an item to be cleaned preferably includes a delivery head having an outlet surrounded by a plurality of inlets for collection of the fluid stream after it has impinged on the said surface, and the pressure variations may be at an ultrasonic frequency or a lower frequency.

Alternatively, of course, the means for directing a stream of fluid at or over the surface of an item to be cleaned may include a delivery head having an array of outlets surrounding an inlet of the said collection means.

In either alternative the means for directing the stream of fluid preferably act to direct the fluid at the surface at an angle other than, and preferably less than, 90° to the surface.

The delivery head may be provided with means for forming a temporary seal to resist escape of fluid around the region of the surface at which the fluid is directed by the fluid directing means.

The delivery head may be so formed that the region around the area of incidence on the surface to be cleaned at which the fluid is directed is subjected by the fluid motion to a reduction below ambient pressure. This can be achieved, for example, by application of the Bernoulli effect achieved by a suitable shape of the delivery head ports and passages.

The collection means preferably delivers the fluid back to the means for directing the fluid stream at the target area of the surface to be cleaned, and it is, of course, preferable that material dislodged from the surface by entrainment in the fluid stream is removed from the collection fluid before the latter is returned to the fluid directing means.

Removal of dislodged material from the fluid stream may be effected by filtering. Alternatively it may be effected by cyclonic action.

Furthermore, there may be provided means for pulsing the fluid stream directed at the surface of an item to be cleaned, and such pulses may be applied at an ultrasonic frequency.

The means for introducing a treatment agent may introduce additives to the fluid stream prior to delivery to the

said means for directing it at the surface to be cleaned. Additives may also be introduced at the point of delivery to the surface. Such additives may include, for example, deodorants, insecticides, antiseptic materials and the like. Because the fluid is re-circulated such additives are used most effectively in that they are brought repeatedly into contact with the surface being cleaned rather than having only a single contact followed by dissipation into the atmosphere. Moreover, chemicals which it may be inadvisable to dissipate into the atmosphere for any reason may also be employed without risk.

Embodiments of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a circuit diagram illustrating the general principle of the present invention;

Figure 2 is a sectional view of a delivery head suitable for use in the surface cleaning apparatus of the present invention;

Figure 3 is a sectional view of an alternative delivery head;

Figure 4 is a sectional view of part of a further delivery head;

Figure 5 is a sectional side view through a further embodiment; and

Figure 6 is a schematic perspective view.

Previously cut away for clarity of the embodiment of Figure 5.

Referring now to the drawings, and particularly to Figure 1 thereof the apparatus schematically shown there comprises a re-circulating system generally indicated 11 composed of a motor driven pump or fan 12, a delivery tube 13 a delivery head 14 having a delivery opening 15 and a peripheral seal 16 for sealing around the delivery head 14 when it is placed in contact with a surface 17 to be cleaned. The delivery head also has an outlet or collector opening 18 leading to a collector tube 19 which conveys fluid delivered to the delivery head 14 by the motor driven pump 12 away from the delivery head to a separator unit 20 which, in this embodiment, is illustrated as a filter chamber 21 containing a filter medium 22 through which the fluid is caused to pass as shown by the arrows in Figure 1, leading a return duct 23 leading to the suction side of the motor driven pump 12. This closed circuit system may, for example, re-circulate a gas such as air, or a liquid, and acts to apply energy via the motor driven pump 12 to the re-circulating fluid. As the fluid impinges on the surface 17, delivered through the delivery opening 15 into the delivery head 14, this energy acts to dislodge any particles or material on the surface 17, entraining it with the fluid as it is then conveyed through the collector opening 18 into the collector duct 19.

As the fluid enters the separator chamber 21 the speed of flow falls due to the increased volume, and this allows the fluid to pass relatively slowly through the filter medium 22 which acts to remove the particulate material.

In order to ensure that the fluid is contained within the re-circulating circuit the seal 16, which may be a resilient skirt or the like around the delivery head 14, acts to isolate the interior of the delivery head 14 from the surrounding atmosphere. Of course, such a seal, made by simple pressure, can never by absolutely secure, especially if the surface 17 is a fibrous or tufted carpet, and the design of the delivery head thus preferably such that the pressure obtaining the delivery head is at or below atmospheric pressure. This can be achieved, for example, by suitable shaping of the ports and ducts such that the speed of flow of the fluid is varied whereby to maximise its speed through the relevant portions of the delivery head creating a falling pressure by the Bernoulli effect.

Turning now to Figure 2 there is shown a delivery head having a delivery passage 25 which at its outlet end 26 circumferentially surrounds a central body 27 in the form of a downwardly divergent conical partition having a central baffle 28 and which acts as a collector. The baffle 28 occupies the central region of the downwardly

open mouth of the baffle 27 to define therewith an annular opening 29 serving as the collector opening.

The body 13 of the delivery head 14 has a circumferential seal 31 acting to resist the escape of air delivered along the passage 25. Having impacted the surface 17 the air delivered to the delivery head 14 then passes through the annular opening 29 to a collection passage 32. By providing a central collection opening 29 for the recirculated air the path from the delivery passage 25 through the delivery chamber 26 is generated radially inwardly through the chamber towards the collection passage 29. The embodiment illustrated in Figure 3 is similar to that of Figure 2, but is designed to have an opposite air flow direction, as shown by the arrows in Figure 3. The delivery passage 35 thus delivers air to an annular opening 36 defined between a conical baffle 37 the cone angle of which is considerably less then the corresponding baffle 27 in the embodiment of Figure 2, and the diameter of which at its base is, therefore, correspondingly smaller.

In the embodiment of Figure 4 a delivery passage 40 has a shallowly inclined outlet 41, and is separated from a collection passage 42 by a shaped partition wall 43 which defines a tapering region 44 between itself and the surface 17 to be cleaned. This acts partly to encourage the air stream to pass through tufts of the surface 17

(assuming this is a carpet) and partly to accelerate the air stream such that, due to the ? effect, the transverse pressure experienced in the region between the delivery passage 40 and the collection passage 42 is at a less than ambient pressure thereby avoiding the need for a separate seal.

Referring now to Figure 5 and 6, the alternative embodiment shown is formed as a so-called "upright" cleaner having a lower cleaning body 50 carried on wheels 51 defining a suction hood with air delivery passages 52 through which air at a positive pressure is directed towards the surface 53 to be cleaned. A baffle or guard 54 separates the delivery passages or ducts 52 within the hood 50 from suction passages 55 which lead over the baffle 54, as represented by the arrows in Figure 6, to a suction transfer duct 56 which enters an upper body 57 of the cleaner housing a drive motor 58 and fan system 59 (shown only schematically) which also incorporates a separator system for separating dust particles entrained with the air arriving through the suction transfer duct 56. The separator system may comprise an active phase separator comprising a plurality of parallel disks as described in our co-pending international patent application No. , or alternatively a cyclone separator. The separated dust particles pass out from the fan system and separator 59 through a chute 60 into a collection chamber 61.

In an alternative embodiment, of course, the dust separation may be achieved by a filter medium through which the air is drawn into the suction transfer duct 56 (or after having passed through it)and the drive fans.

From the separation unit 59 air is then driven through a delivery duct 61 which leads to the delivery passages 52 in the hood 50 via a pressurised air delivery duct 63. Just up-stream of the delivery duct 63 is a transverse opening 64 which can be closed by a cassette, cartridge or other container 65 housing a treatment agent which is drawn into the air stream by the ejector effect of the air stream flowing past the nozzle. To enhance this the ducting within the body 57 may reduce in cross-sectional area over a region 66 (see Figure 6) to produce a venturi effect to encourage the introduction of the treatment agent from the cassette 65 into the air stream so that it is carried along through the delivery passages 52 into contact with the surface 53. Such treatment agent may be an insecticide, for example, for the purpose of attacking house dust mite, flea larvae or the like which may be resident in pile carpet, or may be addition cleaning agents such as detergents or other surfactants for encouraging separation of dirt particles from the pile fabric. Such treatment agents can be utilised in high concentrations since the recirculated air delivered through the passages 52 is immediately withdrawn through

the suction passages 55 and recirculated through the machine without escaping to the environment so that the risk of local atmospheric pollution is avoided whilst applying an effective treatment to the surface.

From the suction passages 55 air flowing through the suction transfer duct also passes through an outwardly tapering passage 67 which causes the air stream to slow and thus eventually encourages the separation of dust particles from air.

The machine illustrated in Figures 5 and 6 also has an ancillary tool system 68 with a hose 69 which may be connected by valves (not shown) either to the suction transfer duct 56 or to the corresponding pressurised air delivery duct 63. A nozzle 70 at the end of the ancillary hose 69 is thus able to provide suction or pressurised air delivery according to the required ancillary operations.

CLAIMS

1. A cleaning device having means for directing a stream of fluid at or over the surface of an item to be cleaned whereby to dislodge material therefrom as a result of the kinetic energy of the fluid stream, means for collecting substantially the entirety of the fluid stream after impact at the said surface, together with any entrained particles dislodged from the surface thereby, and means for introducing into the said fluid stream a treatment agent to be brought into contact with the surface by the said fluid stream.

2. A cleaning device as claimed in Claim 1, in which the means for directing a stream of fluid at or over the surface of an item to be cleaned includes a delivery head having an outlet surrounded by a plurality of inlets for collection of the fluid stream after it has impinged on the said surface.

3. A cleaning device as claimed in Claim 1, in which the means for directing a stream of fluid at or over the surface of an item to be cleaned includes a delivery head having an array of outlets surrounding an inlet of the said collection means.

4. A cleaning device as claimed in any of Claims 1 to 3 in which the means for directing a stream of fluid act

to direct the fluid at an angle less than 90° to the surface.

5. A cleaning device as claimed in any preceding claim, in which the delivery head is provided with means for forming a temporary seal to resist escape of fluid around the region at which the fluid is directed.

6. A cleaning device as claimed in any preceding claim, in which the delivery head is so formed that the region around the area of incidence on the surface at which fluid is directed is subjected by the fluid motion to a reduction below ambient pressure.

7. A cleaning device as claimed in any preceding claim, in which the collection means delivers the fluid back to the means for directing the fluid stream at the target area of the surface to be cleaned.

8. A cleaning device as claimed in any preceding claim, in which removal of the said collected material is effected by cyclonic action.

9. A cleaning device as claimed in any preceding claim, in which there are further provided means for pulsing the fluid stream directed at the surface of an item to be cleaned.

10. A cleaning device as claimed in Claim 9, in which the pulses are applied at an ultrasonic frequency.

11. A cleaning device as claimed in Claim 10, in which an ultrasonic transducer is located in the delivery duct by which the fluid is directed to the surface to be cleaned.

12. A cleaning device as claimed in Claim 11, in which the ultrasonic transducer is located in the vicinity of the said delivery head.

13. A cleaning device as claimed in any preceding claim, in which the said means for introducing a treatment agent comprise means for introducing an additive to the fluid stream prior to delivery to the said delivery head.

14. A cleaning device as claimed in any preceding claim, in which the fluid stream is a gas.

15. A cleaning device as claimed in Claim 14, in which the gas is air.

16. A cleaning device as claimed in any preceding claim, in which treatment agent is a deodorant.

17. Apparatus for use in cleaning a surface having means for recirculating a fluid in contact with the surface and

means for separating from the recirculating fluid material entrained therewith as a result of its contact with the said surface, in which there are provided means for introducing pressure variations into the stream of fluid directed at the surface.

18. Apparatus as claimed in Claim 17, in which the fluid is a gas and is directed with high energy at the surface such that the energy dislodges dirt.

19. Apparatus for use in cleaning a surface, substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

Application No: GB 9910585.0 **Examiner:** Fiona Warner
Claims searched: 1-16 **Date of search:** 14 October 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): A4F - (FSSX, FSLA, FSLX, FSNB, FSNS, FSNX, FFF)

Int Cl (Ed.6): A47L - (5/14, 9/08, 11/00, 11/20, 11/34)

Other: Online: WPI and EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	US 5485651 A	(PAYEUR) - column 1, lines 45-47 and 58-63;column 2, lines 7-10 and figures	1,2,4 at least
X	US 4023233 A	(PRESTWICH) - column 1, lines 29-41; column 2, lines 33-41 and figures	1,4,5
X	US 4103519 A	(DAVIDSON) - column 1, lines 62-66; column 2, lines 6-21 and 65-67; column 3, line 63 to column 4, line 7	1,7,10-12

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.